IRRIGATION AND WATER DELIVERY IMPROVEMENTS USING WIRELESS COMMUNICATION TECHNOLOGY

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ABSTRACT

Radio communications and their advanced flexibility offer technological benefits to new SCADA system deployment as well as a means for upgrading performance to existing SCADA systems. In fact, the limitations and cost of wired systems can be eliminated. Improvements in radio technologies now allow for innovative control and monitoring of SCADA systems thus providing users the ability to more reliably monitor and control devices from a distance. Points within an irrigation system can be brought to a user's fingertips without the expense of running wire or fiber to remote locations. Licensed and unlicensed radios can work in coordination to offer the speed and security to build robust professionally designed SCADA networks. The addition of radio communications to field installed devices or newly deployed systems with RF can prolong the usefulness of existing equipment and ensure years of reliable SCADA network operations. Radio communications offer the flexibility to expand communication capabilities to meet the ever-expanding requirements of fast-growing, high data service areas and SCADA operations.

This presentation will educate and reinforce how wireless radio systems can provide a reliable communication backbone for all of an irrigation organization's analog/digital (I/O), serial and Ethernet challenges.

INTRODUCTION

<u>Save Water, Preserve Resources, Reduce Consumption and Improve Productivity</u>

These are the 100 year mandates that have been presented to us. The challenge ahead is daunting to say the least. Our collective goal is to do more with less; less water, less land, and less labor. In order to accomplish these goals we need to find ways to improve upon our current methods, processes that we have perfected over many, many, many decades. To improve our processes and to achieve success in meeting our goals we need to introduce new technologies into our daily activities and operations.

Our nation's farms and irrigation districts are losing access to water because the world's population is booming and our cities are expanding. At the same time our growing need for food requires that we increase our crop yields to meet the ever increasing demands of the world's population.

Today, we have numerous technologies at our fingertips that can assist in meeting future performance expectations. One simple word that describes these technologies is

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"automation." The same automation that has created information superhighways and has allowed for reduced cost and higher productivity in producing fuels can also be used within the irrigation industry. We must aggressively integrate proven automation methods to meet our specific needs and operational requirements. Some of the available technologies include communication and control improvements. Examples are wireless communication, automated controls, and automated sensors. Each of these technologies is capable of reducing the use of and waste of our water resources. Admittedly, any installation of automation has a price tag, sometimes hefty. It has been proven over and over that the return on investment more than pays for the initial cost of installation of the automated technology improvements in relatively short timeframes.

Automation can be used as we deliver water from one location to another. At each step and function in our water deliver infrastructure we need to consider what options are available to improve our systems. The introduction of automation will allow us to save our way to future demands of our resources. By reducing consumption and loss and by improving our techniques we prolong the useful availability of our streams and rivers, our aquifers, and our reservoirs. In short, we improve our ability to survive the threat of population growth.

Irrigation is a prime example where the integration of automation can result in enormous cost and resource savings. Introduction of an automated systems share a common theme…communication.

Figure 1. Irrigation Pipes

It is essential that a communication network be defined prior to total deployment of automated equipment. Without a robust communication infrastructure to control equipment or gather data (SCADA) the most advanced equipment is left under utilized.

A comprehensive network will allow for district or operation wide communication and/or control. By establishing a reliable communication network which covers the entire service area you allow for unlimited improvement to your processes. This communication network will be the backbone of the entire automation process.

First, it is important to understand the differences and limitations of each available wireless technology. There are landline, cellular, satellite, short-range wireless, long-range wireless, non-licensed or licensed networks, serial and Ethernet, analog or digital. Each of these technologies has positives and negatives as well as limitations. It is up to you to determine what technology or combination of technologies will give you years of reliable operation. In order to determine this you need to establish what you want to accomplish starting today and ending with a completely automated control system (SCADA). Be prepared, sometimes the best network is a 'hybrid' combination of more than one technologies.

Radio controlled systems have been used for decades in almost every industry worldwide to improve efficiencies and to reduce costs. The initial investment in establishing and installing a wireless network can often be recouped through fuel saving and employee overhead / task optimization.

Additionally, recouping initial installation costs will take place as water savings are recognized. It is also possible that saved water can be redeployed to assist in providing additional water to growing metropolitan areas.

Figure 2. Irrigation Turf

Wireless Technologies

As mentioned wireless technologies will be the first and most important aspect of your automation efforts. Therefore, you will need to address the short- and long-term requirements of your network during the early stages of your planning and review process. The first step is to determine how and where you can use wireless.

It is a growing trend to move to a non-licensed radio that allows for continual growth without the restriction or limitation of applying for and owning an FCC operation license. This leaves a very robust ISM (900MHz or 2.4GHz) radio system. These are non-licensed radios that allow for long range, flexible use. ISM or non-licensed radios allow you to use Ethernet backbones with smaller sub-networks “hanging” from the backbone. These sub-networks can be serial (using Mod-Bus or similar protocols) to address each endpoint device. The devices can be controllers, center pivots, or other like devices that actually controls the release of water. It is also possible then to have sensors (moisture detection, flow meters, water levels, weather monitors, etc) installed throughout the operation connected to your network using simple analog or digital (4-20mA or 1-5V) connection.

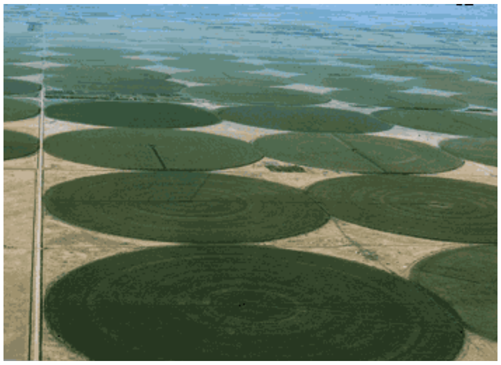

Figure 3. Pivot Irrigation

By establishing this network you have now created a communication and control system that can control flows, establish diversion paths, view performance characteristics and monitor each specific sensor to help determine proper watering patterns throughout your entire service area.

ISM Radios

These radios are available to end-users without the need to apply for or acquire a user license from the FCC. The certification of ISM radios is obtained by the manufacturer and is then assigned to each radio as it is manufactured.

ISM radios are radios that fall into 3 common frequency bands commonly referred to as 900MHz, 2.4GHz, or 5.8GHz. The most frequently used technology used in the U.S. is 900MHz. The 2.4GHz band is used outside the U.S., but is not necessarily approved for use in every country. Please note that 2.4 GHz can also be used without exception in the U.S. as well. Each of these 900MHz radios can/will utilize the entire 902-928MHz band by searching for available channels via ‘hopping’ within the frequency band in search of an open channel. When an open channel is found the radio automatically sends and receives the message or command.

Figure 4. Wireless radio

There is a significant difference in radio technology. Many radios are designed to hear loud, clear signals and they operate best in low noise areas. Others radios are designed to hear “quiet” transmission in a noisy area. This difference is what can separate a decent radio from a great radio. It is important to realize that there are a few additional key characteristics inherent in each radio that help determine its ability to operate reliably in all/most conditions. These key characteristics are not the sole performance capabilities that make a radio perform well but they are very important as you begin your search. Always look at a radio’s sensitivity (don’t get excited simply by published datasheet specifications), ‘hopping speed,’ and ability to avoid interference. These three characteristics will eliminate many lesser performing radios as you begin your search. It is very important to not underestimate the importance of these characteristics because every location has radio frequency (RF) noise in the area. Noise is generated from other RF devices in the area (sometimes from devices installed 20-30 miles away). A good radio will be able to separate/ignore noise from other radios/systems and focus only the signal from your system.

The next crucial step is to test radios in real world situations, not just in a laboratory setting. Laboratory settings generally provide optimal conditions where noise or interference is reduced. Field or pilot testing will show how well a radio will perform when unexpected conditions present themselves.

As you perform/install your pilot, test the radio's flexibility by creating sub-networks by pre-determining signal paths, by calculating and creating situations where you have heavy traffic which will simulate potential overloading of a network. Also, make sure you attach the radio to current equipment in the field. You will do this to determine if the radio can speak with multiple protocols or can work with multiple devices manufactured by different vendors. You also want to install radios at the furthest points of your service area to determine proper coverage. If a particular radio can not communicate all the way back to the 'master' you will want to determine if the radio vendor you are using will allow you to use a like radio to act as a repeater. Ideally, any repeater radio will also allow for an additional device (multiple ports) to be connected. This will help reduce the total number of radios being installed and ultimately your system cost.

There are many crucial aspects to a field pilot study and failure to do a proper field study can result in a underperforming disappointing system. There is no 'cookbook' that works in all situations so it is important that you establish specific criteria that accurately represents the goals of your ultimate communication network.

SUMMARY

In summary, there are a many modifications that can save enormous amounts of water, improve efficiencies within systems and decrease the total amount of water being used. The starting point to improving any operational irrigation system is to improve the communication and control backbone of these systems.

It is possible to establish full automation into the processes of irrigation within the area being served. The use of a performance appropriate wireless network is mandatory in operating a system that is capable of controlling and monitoring district wide performance. By installing a wireless network, real time data or control can be managed from a central location with minimal human interaction. The communication network will provide the range and flexibility to reach each and every device required to improve the overall performance of your perfect SCADA system.